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Brigadier General A. D. Starbird
U. S. Atomic Energy Commission
Division of Military Application
Washington, D. C.

SUBJECT: Mid-Year Review of the LRL, Livermore Program

Dear General Starbird:

1. In reviewing the program of the Lawrence Radiation Laboratory, Livermore, for 1959, the current moratorium on nuclear weapons testing continues to be the most important factor. This handicap and uncertainty, combined with a heavy commitment to a number of very important weaponization programs, produce an anomalous situation in which both factors work to inhibit device development on advanced concepts, which is vital to the development of future weapons. This situation will be temporary as regards the balance between weaponization and device effort, and may also be temporary as regards the test moratorium, but, of course, it creates serious problems for LRL.

The Livermore Laboratory regards nuclear explosives development, and specifically the development of nuclear weapons, as its most important job for the foreseeable future whether or not testing resumes.

With further weapons testing in the next five years a number of radically new device developments will take place. Beyond five years, prediction is meaningless in this field. We do not imply that new developments will cease at that time. The new devices, we believe, will be not only important but necessary for the United States, if it is to keep its defensive and offensive capability for both limited and strategic war, in the present highly competitive situation. with respect to Russia or USA?

[redacted]

This document has been reviewed by a DC/RO and confirmed to be UNCLASSIFIED.
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Date: 02/20/2024
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J. Diaz 9/21/83
REVIEWED BY DATE 11/26/80

If testing does not resume, it will be necessary to develop new techniques which do not involve nuclear weapons tests, to carry us as far as possible in the development of new nuclear weapons. Depending on the nature of the designs involved and the full yields desired, one can hope for a substantial measure of development. It is clear, however, that the rate of progress in weapons development would be very markedly decreased by a continuance of the moratorium, even if substitute development efforts were expanded. By means of such expedients as the use of the Vortex facility, by more extensive and elaborate calculations, use of mechanical safing and a more liberal use of fissile material in device design, etc., we would hope even under circumstances of a complete moratorium to be able to make one or perhaps two generations of weapons development progress, at least in some areas.

2. While the uncertainty persists, the Laboratory is making a very extensive effort to become and remain prepared for testing underground and in deep space so as to be able to perform such tests if national policy so decides. We consider it our responsibility to be able, in such a case, to obtain the necessary diagnostic data. This constitutes our principal effort in the testing area which has been cut back from 350 during Hardtack to a level of the order of 150 direct personnel.

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So far as future developments are concerned, we have in mind a great many devices, to most of which we have been able to devote only conceptual effort

and preliminary calculations. In the area of high yield warheads, we have been thinking about a possible [redacted] device in the 3000-pound weight class. We are fairly convinced that this approach with further testing could give 10 megatons. It will certainly be desirable to have as large a yield as possible developed for the Titan system.

It also seems almost certain that the 600-pound weight class will constitute a substantial fraction of our missile capability through the time period 1965-66, as embodied both in the Minuteman and in the Polaris systems, each of which has very important advantages in probability of surviving an initial strike. We believe that on the basis of past tests, we can produce a warhead of 0.8 megatons if this is desired for these missiles, but at a very substantial cost in oralloy [redacted] we believe that we can obtain a yield in the neighborhood of a megaton [redacted] DELETED

[redacted] it may be possible to boost the yield up to the two-megaton range, or conceivable even beyond. These [redacted] designs, however, would certainly require nuclear tests. [redacted] DELETED

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A class of possible high yield weapons which has become interesting to the users only in the past year or so is that of weight of 50-200 pounds with yields of 75-500 kilotons for the late 1960's. Several purposes exist. The most important seems to be a very light ICBM (5000-10,000 pounds) which can then be made roadable or even transported over open country, perhaps in a moderately hardened configuration

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The program to reduce the amount of fissionable material required

seems quite promising.

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As has been mentioned above several times, new primary designs are of great importance

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Theoretical work during the last few months has greatly increased our interest in clean or partially clean weapons of low weight.

DELETED ecent studies indicate that some designs of these weapons are probably attainable in the next weapons testing series, although without tests, no reliable system is likely to be developed. Some of these devices have been described in detail in recent Washington briefings and our plans concerning these devices are discussed in detail in a separate letter (BY-59-102).

It is obvious that our possible plans greatly exceed the capabilities of the Laboratory and therefore we intend to use great selectivity. Even so, we feel that more manpower is required to continue effective weaponization and at the same time to advance the most hopeful and important among the devices described. We feel that the development of a [redacted] arhead and the light weight [redacted] eapon are necessary components of the Laboratory programs and even these place extremely heavy requirements upon our present manpower.

4. In the Plowshare program, we are increasing our effort towards the 150 direct heads authorized for this fiscal year. At present, we are at about half that level. Our interests continue to lie principally in the fields of excavation, mineral development (including oil and water), and isotope recovery and power generation. The plans for Operations Chariot and Gnome are continuing,

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with scaled-down shots planned for Operation Oxcart to give us further information on the best burial depth for excavation purposes. The most sensible schedule for Chariot would now appear to be early in Calendar 1961 following two summers of biological and ecological study, with operational arrangements including drilling of shot holes during the summer of 1960. Gnome is now scheduled for the middle of Calendar 1960, and is regarded as very experimental and exploratory in nature, in contrast with Chariot which should provide a concrete example of how an excavation would be made. The Laboratory may have to undertake considerable preparatory effort in the second half of 1959 in connection with a tar sand shot in the Athabasca Basin or an oil shale shot in Colorado, provided that the respective oil groups involved make the proper arrangements with the AEC and the Canadian authorities.

Recent developments in nuclear explosive design for excavation purposes appear very promising. The so-called Ditchdigger principle, when combined with [redacted] appears to provide long term promise of being able to produce excavations for harbors or canals, or the removal of overburden for mining purposes, with very greatly reduced radioactivity and reduced costs. Even complete elimination of radioactive release to the atmosphere is within the realm of possibility. This would be a most important factor in making acceptable to the public such shots in areas closer to population centers. It could well be that comparatively shallow burial of a small diameter pipe could produce a canal 600 feet wide and one or two hundred feet deep at an oralloy or tritium cost of a few hundred thousand dollars per mile, and perhaps a million dollars per mile total cost (or the order of 10 cents/cubic yard). Therefore, we are placing considerable emphasis at the present time on the development and design of nuclear experiments directed toward such cheap and clean ditchdiggers.

5. The Laboratory has developed a very substantial interest in geophysics of various kinds. Some of these have developed in connection with the problem of detection of nuclear tests; some of them in connection with the Plowshare program; and some of them separately from either of these.

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a) In connection with detection of tests in the region of space out to ten to the fifth kilometers, ionospheric and upper atmospheric phenomena have been examined. Detectability and the possibility of hiding of shots at extreme distances have been investigated, and in connection with this it is planned to measure the background of X-rays generated by astronomical sources.

b) In connection with detection of underground explosions, the creation and propagation of elastic waves in the layered structure of the earth and related problems in seismological theory are being investigated; these also are of interest in connection with the seismic effects expected from the larger Plowshare explosions. - High explosive shots are planned for the period of next six months, which will give us data concerning detectability and decoupling. These shots also will have relevance for geophysical theory.

c) Plowshare itself also involves questions having to do with properties of various kinds of rocks and the influence of such matters on the breaking or crushing of rock, as well as problems of ground water flow, mineral distribution, etc.

d) There are some preliminary explorations about the use of our computers and other techniques in connection with general meteorological questions. These are of an exploratory character and have arisen partly in connection with AEC programs and partly in connection with special apparatus available at the Laboratory.

e) Finally, such phenomena as Argus have created in the Laboratory an interest in the problem of geomagnetic and related phenomena.

The amount of effort at present going into such studies is not large, amounting to no more than three or four people in each of the half dozen fields mentioned above. It is, however, high quality effort because those interested in it are among our most capable people.

6. Our Pluto effort continues to be directed toward the very limited objective of establishing feasibility of a high-temperature reactor for ramjet purposes. We have resisted and we continue to resist an early conversion of this effort into an all-out systems development. At the same

time there appears to be a justified demand for an early establishment of the feasibility because even if we proceed at the greatest foreseeable rate the system cannot be available before the late 1960's. Therefore, we are seriously considering a stepped-up effort which is needed to provide data on the technical feasibility at an early enough date.

A Pluto-type reactor could also be applied to an effective high temperature breeder. This problem has received so far only minimal theoretical investigation.

7. The Sherwood program continues at approximately its former level of effort. At the present time, emphasis is placed on the mirror machine and particularly on the question of injecting the plasma into this machine. In the field of the mirror machine, the Laboratory has a long established interest which seems to be justified by recent scientific opinion in this country as well as in England and Russia. Our future plans include the use of cryogenic techniques in the Sherwood program which will enable us to produce cheaply, magnetic fields of high intensity.

8. The fundamental research both in physics and chemistry also continues at about the scheduled rate. A number of new experiments have been devised and are planned for execution using the LPTR. The Laboratory has also become involved with a number of measurements having to do with fluxes of radiation outside the earth's atmosphere. One of these involved the nature of the particles and their energy distribution in the lower Van Allen belt of radiation.

By virtue of its ability to produce high neutron fluxes, high pressures, and other unusual physical conditions in a nuclear explosion, the Laboratory is particularly qualified to do studies in such areas as the production of unusual isotopes in nuclear explosions (this is part of the Plowshare program), the measurement of equations of state of various materials in the very high pressure regions (10 megabars or thereabouts) and the production of known sources with which to investigate such geophysical problems as wave transmission through the earth's structure.

9. An important and increasing activity of the personnel in the Laboratory is their service on committees of the AEC and other government agencies.

While this deprives us of full use of the time of some of our ablest people, it also gives us access to information essential for the planning of the future programs of the Laboratory. Furthermore, we believe that the Laboratory must count among its most important duties to make available the best possible advice that our people can give in the fields in which they have acquired special knowledge.

Sincerely,

Edward Teller

Edward Teller
Director
LRL, Livermore

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